

*Citation for published version:*

McCullen, N, Walker, I, Natarajan, S & Padget, J 2014, 'Smart meter roll-out strategy and its effect on energy savings at community level', Behave Energy Conference, Oxford, UK United Kingdom, 3/09/14 - 4/09/14.

*Publication date:*

2014

*Document Version*

Publisher's PDF, also known as Version of record

[Link to publication](#)

**University of Bath**

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# Smart meter roll-out strategy and its effect on energy savings at community level

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## Household Energy Use in the UK

- Buildings consume 20%–40% of total energy.
- Energy consumption results from both technological and behavioural causes.
- UK households are due to be fitted with smart meters by 2019.
- Part of this will be the “In Home Display” (IHD) to give occupants feedback on energy use.
- There is potential for such displays to deliver feedback about the occupants’ own energy use compared to that of others, for example the average of their local neighbourhood or district.

## Energy Consumption Distributions

The total consumption in each band is given by multiplying usage  $u$  (kWh/d) by number of users  $F(u)$  in that usage bracket.  $G(u) = uF(u)$

The total for all users up to each band is the cumulative sum to this value:  $T(x) = \sum_{u=0}^x uF(u)$

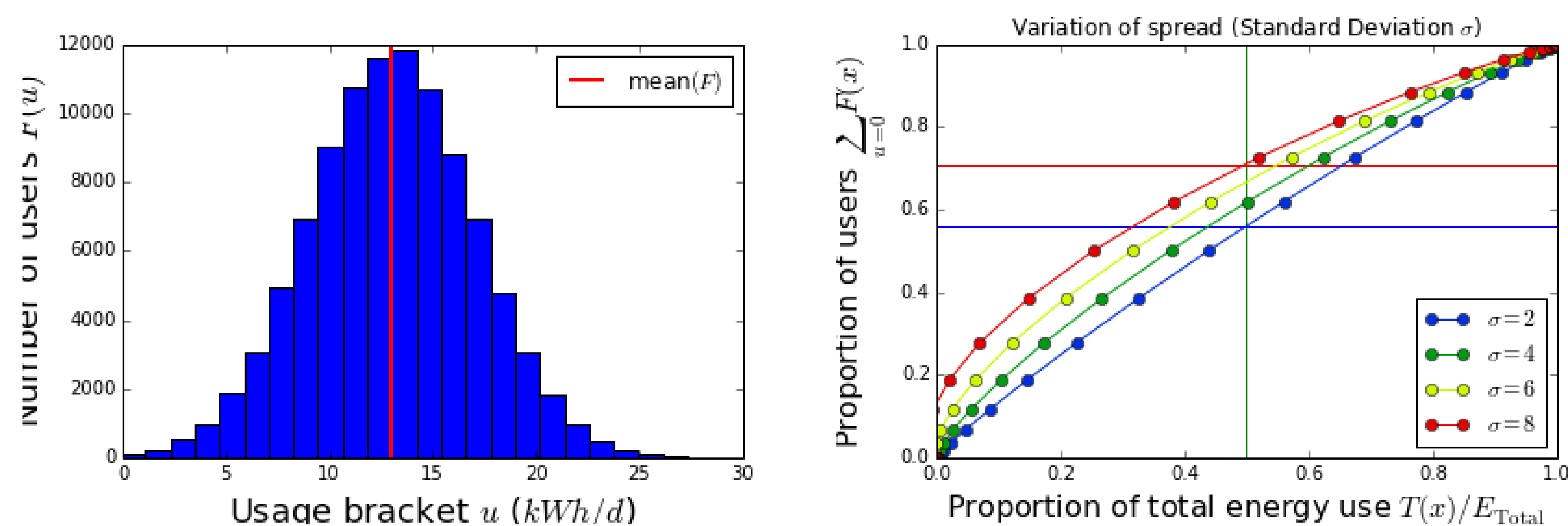


Figure 1: Normally distributed consumption, varying standard deviation  $\sigma$

- High-end tail contributes disproportionately to energy consumption.
- Wider spread of consumption values makes the effect worse.

## Actual Reported Data

Real data is not normally distributed [1]:

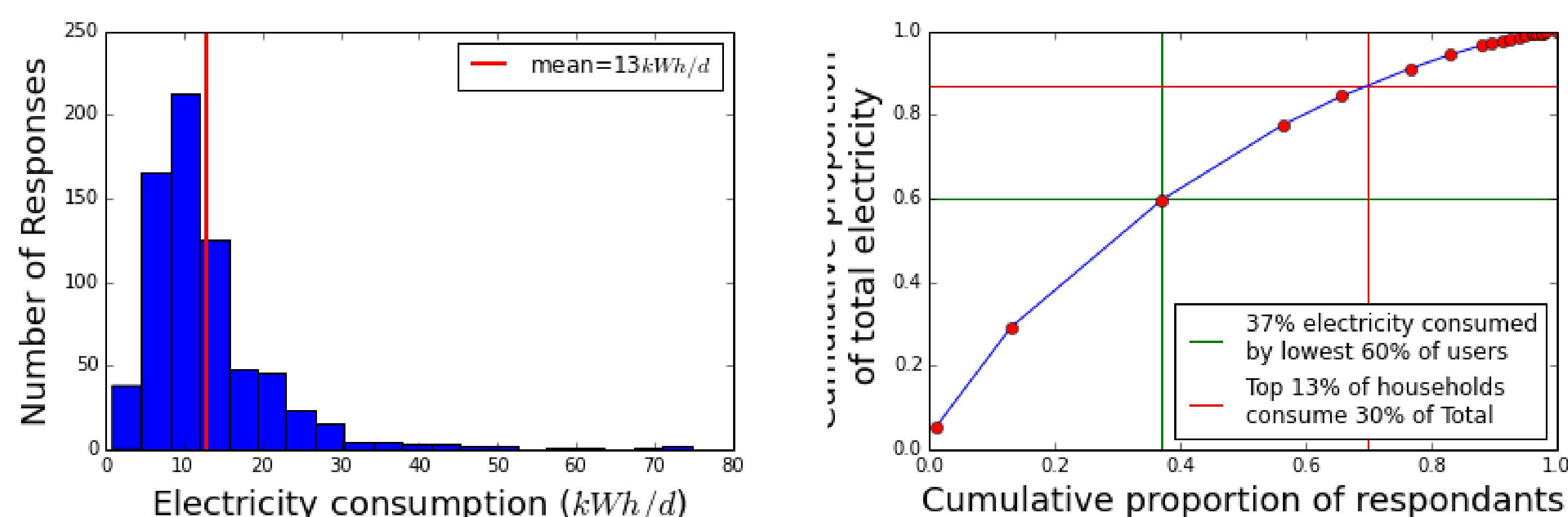


Figure 2: Real data has long-tail

- Effect of high-end tail is exaggerated further.
- Lightest 60% of households consume only 37% of energy but highest 13% use 30% of total.

## Model Distribution

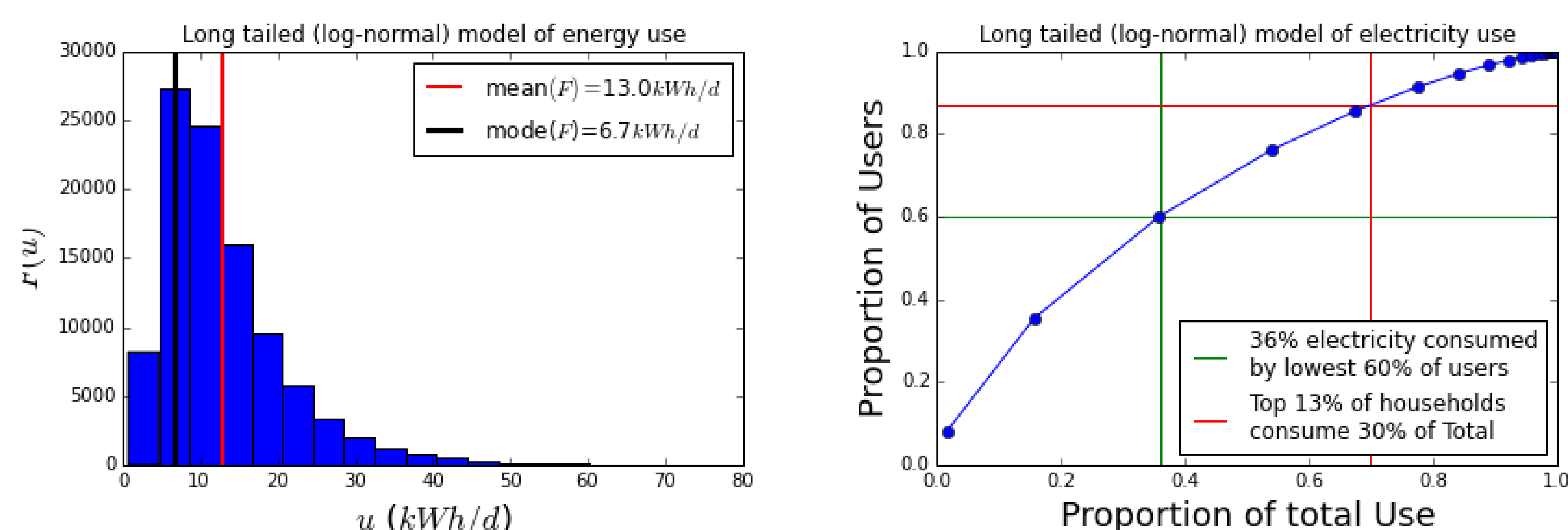


Figure 3: Log-normal distribution used to model the data

- Log-normal distribution can be used to reproduce the features of the real data well.

## Strategic Smart-Meter Roll-Out

- One aspect that could make a difference in peer-comparison applications is the order in which smart-meters are installed.
- Evidence suggests that peer feedback results in lower energy consumers increasing their energy consumption towards the average whilst higher energy consumers try to reduce their consumption resulting in a “regression towards the mean” effect. [5]
- Could this be used to design roll-out strategies to ensure a better systemsatic end-result?

## Energy Behaviour

Adoption of energy-efficient technology/practices are based on a combination of factors [2, 3]:

- a) rational choices based on perceived intrinsic benefit;
- b) social diffusion of idea influenced by inter-personal communication (*social capital*);
- c) interaction with the “mainstream” via observation, media, IHD feedback. . .

## Responding to Different Feedback

- Different types of visual displays can be used.
- feed-back information about own-use as well as peer comparison.



Figure 4: Numerical, analogue and ambient IHD designs and their relative effectiveness. All work well in influencing behaviour [4].

## Asymmetry in Behaviour

Studies show that people respond asymmetrically:

1. Higher than average users reduce energy consumption while low-end users increase [5], unless feedback implies good or bad behaviour (such as smiley faces) . . .
2. Lower-income households have higher incidence of uptake of energy efficiency measures [6].
3. People respond to social cues differently depending on the importance of the decision [7].

## Modelling Asymmetric Responses

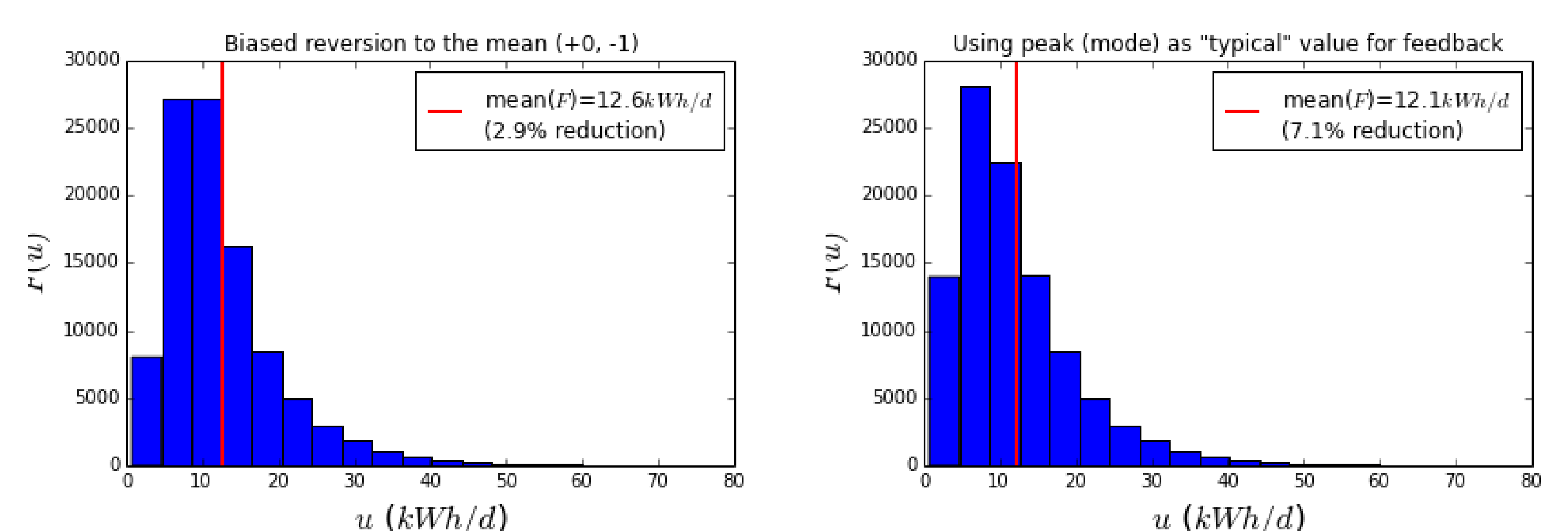


Figure 5: Modelling of effect 1. (above) showing the improved average.

## Conclusions

- Data shows that higher-than-average users both (a) contribute disproportionately to energy use and (b) respond differently to feedback and intervention campaigns.
- We have analysed models taking these effects into account to look at the best strategies for introducing peer feedback through the smart metering infrastructure.
- The results show that effort must be made to influence the high-end users and that the type of display is important in achieving the best result possible.
- The choice of information (mean average or peak) is important for achieving better results.

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